



**“Celebrating Paper!”**

*April/May 2019*

**Reading Supports**

**Teacher’s Guide:**

<http://www.acs.org/chemmatters>



**Teacher’s Guide:**

**Reading Supports**

***“Celebrating Paper!”***

**April/May 2019**

**Table of Contents**

[Reading Supports 3](#_Toc524537155)

[Anticipation Guide 5](#_Toc524537156)

[Graphic Organizer 6](#_Toc524537157)

[Student Reading Comprehension Questions 7](#_Toc524537158)

[Answers to Reading Comprehension Questions 9](#_Toc524537159)

# Reading Supports

The pages that follow include reading supports in the form of an Anticipation Guide, a Graphic Organizer, and Student Reading Comprehension Questions. These resources are designed to help students prepare to read the article and then locate and analyze information from the article.

* **Anticipation Guide (p. 5):** The Anticipation Guide helps to engage students by activating prior knowledge and stimulating student interest before reading. If class time permits, discuss students’ responses to each statement before reading each article. As they read, students should look for evidence supporting or refuting their initial responses.

**Or** consider the following ideas to engage your students in reading:

**Celebrating Paper!**

* Before reading, ask students what kinds of paper they can think of, and why we need so many kinds of paper. Ask students to think about how different kinds of paper are different chemically.
* As they read the article, students should record information they find interesting and the differences in types of paper.
* **Graphic Organizer (p. 6):** The Graphic Organizer is provided to help students locate and analyze information from the article. Student understanding will be enhanced when they explore and evaluate the information themselves, with input from the teacher, if students are struggling. Encourage students to use their own words and avoid copying entire sentences from the article. The use of bullets helps them do this.

If you use the aforementioned organizers to evaluate student performance, you may want to develop a grading rubric such as the one below.

|  |  |  |
| --- | --- | --- |
| **Score** | **Description** | **Evidence** |
| 4 | Excellent | Complete; details provided; demonstrates deep understanding. |
| 3 | Good | Complete; few details provided; demonstrates some understanding. |
| 2 | Fair | Incomplete; few details provided; some misconceptions evident. |
| 1 | Poor | Very incomplete; no details provided; many misconceptions evident. |
| 0 | Not acceptable | So incomplete that no judgment can be made about student understanding |

* **Student Reading Comprehension Questions (p. 7):** The Student Reading Comprehension Questions are designed to encourage students to read the article (and graphics) for comprehension and attention to detail, to provide the teacher with a mechanism for assessing how well students understand the article and/or whether they have read the assignment, and, possibly, to help direct follow-up, in-class discussion, or additional, deeper assignments.

Some of the articles in this issue provide opportunities, references, and suggestions for students to do further research on their own about topics that interest them.

To help students engage with the text, ask students which article **engaged** them most and why, or what **questions** they still have about the articles. The “Web Resources for More Information” section of the Teacher’s Guide: Tools and Resources provides sources for additional information that might help you answer these questions.

Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

## Anticipation Guide

**Directions: *Before reading the article*,** in the first column, write “A” or “D,” indicating your agreement or disagreement with each statement. As you read, compare your opinions with information from the article. In the space under each statement, cite information from the article that supports or refutes your original ideas.

|  |  |  |
| --- | --- | --- |
| **Me** | **Text** | **Statement** |
|  |  | 1. The composition of most paper comes from tree fibers. |
|  |  | 1. Cellulose is the most abundant natural polymer. |
|  |  | 1. Both the length and width of wood fibers depends on the type of tree it comes from. |
|  |  | 1. Cellulose is hydrophilic (“water-loving”). |
|  |  | 1. Hydrogen bonding holds toilet paper together. |
|  |  | 1. Cellulose, sugars, and starches are carbohydrates. |
|  |  | 1. Sturdy paper such as mail envelopes have hydrophilic compounds added to them. |
|  |  | 1. Recycling facilities must separate the different types of paper prior to recycling. |
|  |  | 1. Paper towels have fewer covalent bonds than toilet paper. |
|  |  | 1. Natural paper is bright white. |

## Graphic Organizer

Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Directions**: As you read, complete the graphic organizer below to compare different ingredients in paper. The last row refers to a hydrapulper, which is explained in the article.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **What is it?** | **Structure** | **Properties** | **Interesting fact** |
| **Cellulose** |  |  |  |  |
| **Wood fibers** |  |  |  |  |
| **Microfibrils** |  |  |  |  |
| **Sizing agents** |  |  |  |  |
| **Hydrapulper** |  | *How does it work?* | |  |

**Summary:** In the space below, or on the back of this paper, write a short sentence (20 words or less) summarizing the article.

## Student Reading Comprehension Questions

Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Directions**: Use the article to answer the questions below.

* 1. In the table below, list three properties and a use for each that make paper useful for humans.

|  |  |
| --- | --- |
| **Property** | **Use** |
|  |  |
|  |  |
|  |  |

* 1. What are three characteristics of tree fibers that provide paper’s versatility?
  2. Complete the table below regarding types of wood fibers.

|  |  |  |  |
| --- | --- | --- | --- |
| **Type of  wood fiber** | **Source** | **Length  of fiber** | **Use** |
|  |  |  |  |
|  |  |  |  |

* 1. What force binds the long polymeric chains of cellulose to each other, forming rigid crystalline regions?
  2. What is the composition of tree cell walls?
  3. (a) Define hydrophilic, and (b) explain what effect this property has on cellulose.

**Student Reading Comprehension Questions, cont.**

* 1. Why do some paper products, like toilet paper, come apart easily in water?
  2. How does a hydrapulper work to help recycle paperboard products?
  3. (a) What are sizing agents used on paper, and (b) how do they work?
  4. What is done to paper towels to make them (a) strong, and (b) absorbent?
  5. What substance is added to printer paper to make it appear brighter or whiter?

**Critical-Thinking Questions**

***Write your answers on another piece of paper if needed.***

* 1. Cellulose is a polysaccharide found in plants, while glycogen is a polysaccharide found primarily in animals. Research and then prepare a table comparing the composition and structure of cellulose and glycogen, including their monomers, bonding links, strengths, solubilities, sources, and uses.

1. The article mentions, but it does not completely describe, holocellulose, cellulose, and hemicellulose. Research and explain the composition and relationships among these three components.

## Answers to Reading Comprehension Questions

1. **In the table below, list three properties and a use for each that make paper useful for humans.**

|  |  |
| --- | --- |
| **Property** | **Use** |
| Can be clean and bright | For writing notes |
| Can be tough | To form shipping boxes |
| Can be soft and absorbent | To wipe noses |

1. **What are three characteristics of tree fibers that provide paper’s versatility?**

Three characteristics of tree fibers that provide paper’s versatility are

1. strength,
2. flexibility, and
3. the ability to bond to each other.
4. **Complete the table below regarding types of wood fibers.**

|  |  |  |  |
| --- | --- | --- | --- |
| **Type of  wood fiber** | **Source** | **Length  of fiber** | **Use** |
| Longer | Evergreen trees | 3–5 mm | Reinforce paper |
| Shorter | Deciduous trees | 1.2 mm | Make paper smooth |

1. **What force binds the long polymeric chains of cellulose to each other, forming rigid crystalline regions?**

Hydrogen bonds are the forces binding the cellulose chains to each other and forming rigid crystalline regions.

1. **What is the composition of tree cell walls?**

Tree cell walls are composed of multiple layers of microfibrils, which are composed of cellulose

1. **(a) Define hydrophilic, and (b) explain what effect this property has on cellulose.**
2. The term hydrophilic means “water-loving”.
3. The effect of cellulose absorbing water is that it softens the fiber wall, and the wall becomes more flexible.
4. **Why do some paper products, like toilet paper, come apart easily in water?**

Some paper products, like toilet paper, have only hydrogen bonds acting between the cellulose chains. So, water can get between the hydrophilic cellulose chains and break the hydrogen bonds, allowing the fibers to disperse.

1. **How does a hydrapulper work to help recycle paperboard products?**

A hydrapulper helps to recycle paperboard products by vigorously mixing the paperboard with water—like a big blender—which allows the fibers to easily separate from each other for cleaning and re-use.

1. **(a) What are sizing agents used on paper, and (b) how do they work?**
2. Sizing agents used in paper are organic molecules that are hydrophilic on one end and hydrophobic on the other.
3. The hydrophilic end of the sizing agent covalently binds with cellulose during the drying process, with the hydrophobic end facing out toward the surface of the paper—which helps to slow down the absorption of water by the paper.
4. **What makes paper towels (a) strong, and (b) absorbent?**
5. Paper towels have polymeric cross-linkers added to form covalent bonds between the cellulosic fibers, so that water can enter the structure without the fibers separating from each other, making them strong.
6. At the same time, the amount of bonding in paper towels is limited. This keeps the density low, so lots of internal spaces are available for liquids to flow into, making them absorbent.
7. **What substance is added to printer paper to make it appear brighter or whiter?**

Calcium carbonate (CaCO3), mined as marble or chalk or prepared synthetically, can be added to paper to make it appear brighter or whiter.

**Critical-Thinking Questions**

1. **Cellulose is a polysaccharide found in plants, while glycogen is a polysaccharide found primarily in animals.** Research and then prepare a table comparing the composition and structure of cellulose to glycogen, including their monomers, bonding links, strengths, solubilities, sources, and uses.

|  |  |  |
| --- | --- | --- |
|  | **Cellulose** | **Glycogen** |
| **Monomer** | Glucose | Glucose |
| **Bonding link** | Beta linkage (β(1-4) glycosidic bonds) | Alpha linkage (α(1-4) glycosidic bonds) |
| **Strength** | Stronger than glycogen | Much weaker than cellulose |
| **Solubility** | Insoluble in water | Soluble in water |
| **Source** | Plant cell walls | Animal and fungi |
| **Use** | Structural strength | Energy storage |

1. **The article mentions, but it does not completely describe, holocellulose, cellulose, and hemicellulose. Research and explain the composition and relationships among these three components.**

Holocellulose is the total polysaccharide component of wood and other woody materials. It is composed of the cellulose plus the hemicellulose in a plant. Cellulose is an unbranched polysaccharide composed of only glucose monomers with beta-linkages. Hemicellulose is a much shorter, branched polysaccharide that is composed of many different sugar monomers including glucose, xylose, mannose, and galactose. Hemicellulose serves to connect microfibrils together. So, cellulose and hemicellulose are two different polysaccharides that, together, comprise holocellulose (from Greek *holos* “whole” or “total” + cellulose).